



**National Weatherization Assistance
Program Evaluation**

Results Report

Non-Energy Benefits of WAP

**Estimated with the Client Longitudinal Survey
Final Report**

January 2018

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Executive Summary

The National Weatherization Assistance Program (WAP) Evaluation included surveys with program participants before and after they received the program treatments. One of the key goals of the data collection effort was to estimate the impact of WAP on outcomes beyond energy usage, including health, safety, comfort, and affordability. This report provides a description of the research conducted and an analysis of WAP's impact on these non-energy benefits.

Overview

All of the findings in the report are based on analysis of the pre- and post-WAP treatment Occupant Survey data. We analyze the change in the incidence of issues related to health, safety, comfort, and affordability after receiving WAP treatments, as compared to the change for a Comparison Group of earlier WAP participants.

Non-Energy Benefits

The non-energy benefits that may arise from WAP cover many issues, some of which are addressed in this study, some were addressed in other WAP studies, and some were not addressed by the WAP evaluation. The benefits studied in this report include affordability, home condition, home comfort, health, and safety.

Methodology

Pre- and Post-Treatment Occupant Surveys were included in the WAP evaluation to assess the program in ways that went beyond the utility and program data. One important purpose of the Occupant Surveys was to provide estimates of non-energy benefits that resulted from the WAP treatments. Data on affordability, housing conditions, comfort, safety, and health status indicators were collected before and after WAP service delivery for a Treatment and a Comparison Group.

The Baseline Survey was conducted prior to the Treatment Group's home energy audit. The Follow-Up Survey, completed 12 to 18 months following service delivery, at the same time of year as the Baseline Survey, assessed the same indicators to determine how client status and needs changed. The Comparison Group was surveyed at the same time as the Treatment Group, but had already received service delivery at the time of the Baseline Survey. Therefore, the change for Comparison Group provides an assessment of how needs and conditions may have changed due to factors external to WAP. The Comparison Group assessment is a post-post-treatment change measurement.

By estimating the differences in client status before and after WAP for the Treatment Group, and netting out a similar post to post difference for the Comparison Group, this evaluation design attempts to isolate the impact of WAP. It is important to understand that survey respondents were not asked to report on how participation in WAP affected energy affordability, the condition of their housing unit, their comfort, their health status, or their

safety. Rather, in each survey the respondent was asked to report the current status on a number of dimensions. Estimates of net changes were developed by comparing the Baseline Survey (pre-weatherization) status reports to the Follow-Up Survey (post-weatherization) status reports.

Affordability

Several affordability and bill payment indicators were examined in this research.

- **Affordability of Energy and other Needs:** Ten indicators were examined, including difficulty paying energy bills, tradeoffs in paying energy and utility bills, use of short-term loans, ability to afford food, going without food, worries about nutritious food, and ability to afford medicine.

Only one of these ten indicators showed a statistically significant net change. While 76 percent of participants said it was very hard or hard to pay their energy bills prior to WAP participation, 49 percent said it was very hard or hard following participation, a reduction of 26 percentage points. While the Comparison Group experienced a small decline in such difficulty, the net change was a decline of 20 percentage points.

While elderly households experienced the same net decline of 20 percentage points in saying it was very hard or hard to pay the energy bills, families with children did not have a statistically significant difference.

- **Bill Payment:** Three indicators were examined with respect to bill payment including receipt of disconnection notices, termination of electric or natural gas service, or ran out of fuel. The one statistically significant net change was a decline of three percentage points in those who ran out of fuel. This was an eight percentage point net decline for those in the moderate climate zones.
- **Living Situation Disruptions:** Six indicators were examined with respect to living situation disruptions including the need to move due to energy bills, evictions, foreclosures, moving in with others or into a shelter, and family separation over the last five years. There was no meaningful impact on any of these measures.

WAP helps to improve energy affordability over the long term for low-income households by reducing the cost of energy by over ten percent on average. In addition, since the WAP Evaluation Impact Reports show that the program delivers higher savings to households with higher energy usage and higher priced fuels, it is likely that the affordability impacts for such households are larger than for the average household.

The Occupant Survey analysis does not furnish evidence that WAP has a statistically significant impact on the ability of low-income households to maintain their energy service or to pay for other necessities. Additional research on programs that are more targeted to address the energy affordability issue are needed to better document such program impacts.

Housing Conditions and Home Comfort

We looked at a number of indicators related to housing conditions and home comfort.

- **Pest Infestation:** Four indicators were examined with respect to pests and three of the four indicators had statistically significant net changes. While 19 percent of the Treatment Group stated that their home was somewhat infested with cockroaches, spiders, or other insects prior to WAP, 12 percent said it was somewhat infested after WAP, a seven percentage point reduction. The Comparison Group had a three percentage point increase, resulting in a net reduction of ten percentage points. Other changes were smaller.

Changes in the incidence of pests were largest in the moderate climate zone, but were seen in all climate zones.

- **Mold and Water:** Four indicators were examined with respect to mold and water, and two of the four indicators had statistically significant net changes. While 29 percent of the Treatment Group stated that their home had a mildew odor or musty smell prior to WAP, 21 percent said there was such an odor after WAP, an eight percentage point reduction. The Comparison Group had a one percentage point increase, resulting in a net reduction of ten percentage points. Participants were also less likely to report that they sometimes observe standing water.

Reductions in the presence of a mildew odor or musty smell, and in mold, were only found in the cold climate zone. Reductions in observed standing water were found in the very cold and hot climate zones.

- **Noise:** Two indicators were examined with respect to noise and there was a large impact on those who reported a great deal of noise. While 28 percent of the Treatment Group stated that there was a great deal of noise prior to WAP, 17 percent said there was a great deal of noise after WAP, a 12 percentage point reduction. The Comparison Group had no change, resulting in a net reduction of 12 percentage points.
- **Draftiness:** Two indicators were examined with respect to draftiness and both had a statistically significant net change. While 17 percent of the Treatment Group stated that the home was drafty most of the time prior to WAP, four percent said the home was drafty most of the time after WAP, a 12 percentage point reduction. The Comparison Group had a two percentage point reduction, resulting in a net reduction of ten percentage points.
- **Indoor Temperature:** Ten indicators with respect to indoor temperature were examined and five changes had statistically significant net impacts. While 58 percent of the Treatment Group stated that the home's winter temperature was comfortable prior to WAP, 82 percent said the home's winter temperature was comfortable after WAP, a 23 percentage point increase. The Comparison Group had a four percentage point increase,

resulting in a net increase of 20 percentage points. They were also less likely to state that the home was too cold.

There was also a positive impact in the summer. While 57 percent of the Treatment Group stated that the home's summer temperature was comfortable prior to WAP, 71 percent said the home's summer temperature was comfortable after WAP, a 13 percentage point increase. The Comparison Group had a two percentage point increase, resulting in a net increase of 12 percentage points. They were also less likely to state that the home was very hot in the summer.

- **Temperature Impact:** Six indicators were examined with respect to the impacts of the home's indoor temperature including difficulty studying and whether the temperature was unsafe. Neither of the studying impacts were meaningful or statistically significant, but three of the four unsafe temperature impacts were.

While 81 percent of the Treatment Group stated that the home never had an unsafe or unhealthy indoor temperature prior to WAP, 93 percent said the home never had an unsafe or unhealthy temperature after WAP, a 12 percentage point increase. The Comparison Group had no change, resulting in a net increase of 12 percentage points.

It is clear that the comprehensive services delivered by WAP resulted in important changes in housing conditions for a significant share of treated homes. One important question, however, is whether the program could have done even more with respect to housing unit conditions. For example, while there was a ten percentage point net reduction in the incidence of homes with a mildew odor or musty smell, the Follow-Up Survey found that about 20 percent of households still had a mildew odor or musty smell after receiving weatherization services.

Health Benefits

We looked at several indicators related to the health benefits associated with WAP. There were only a small number of dimensions on which there were statistically significant improvements for households that participated in WAP.

- **Access to Medical Care:** Three indicators of health insurance coverage were examined and there were no statistically significant net changes in any of these indicators.

Five indicators were examined with respect to access to medical care including ability to afford to see a doctor, ability to afford prescriptions, and problems paying medical bills. There were statistically significant net impacts on three of those indicators.

While 23 percent of the Treatment Group stated that they could not afford to see a doctor with health insurance coverage prior to WAP, 15 percent said they could not afford to see a doctor with coverage after WAP, an eight percentage point decline. The Comparison Group had a two percentage point decline, resulting in a net decline of

seven percentage points. They were also less likely to state that they could not afford prescriptions.

While households with elderly members were less likely to report that they could not afford to see the doctor with coverage and could not afford their prescription with coverage following the WAP treatment, households with children were less likely to report that they could not afford the prescription without coverage following WAP treatment.

- **Physical and Mental Health:** Three indicators of physical and three indicators of mental health status were examined. There was one statistically significant net impact on physical health. While 23 percent of the Treatment Group stated that they had poor physical health all of the past 30 days prior to WAP, 18 percent said they had poor physical health all of the past 30 days after WAP, a five percentage point decline. The Comparison Group had a four percentage point increase, resulting in a net decline of eight percentage points.

The elderly had a net decline of twelve percentage points in having had poor physical health all of the past 30 days, but households with children did not have a statistically significant impact.

- **Sleep:** Three indicators of enough sleep and three indicators of ability to do usual activities were examined. There were no significant net impacts on these variables.
- **Asthma:** Twelve indicators were examined with respect to asthma conditions and symptoms including whether the respondent had asthma, doctor visits for asthma, time since last asthma symptoms, and hospital visits for asthma. There were no significant net impacts on these variables.
- **Medical Conditions:** Ten indicators were examined relating to medical issues including need for medical attention due to home temperature, health symptoms, and medical issues verified by a doctor. There were no significant net impacts on these variables, but there were some statistically significant net changes in certain population subgroups.
- **Earnings:** Twenty-one indicators were examined relating to earnings impact including work days missed by primary wage earner due to illness or injury and school days missed due to illness or injury. There was a net decrease in the percent with no days of work missed of six percentage points and a net increase in those with one to five days missed of six percentage points, showing a worsening of this indicator.

The study found that there were a few statistically significant improvements in the health status of program participants. However, on most dimensions, there were no statistically significant changes.

Safety Benefits

The safety benefits that were examined included the presence of home safety devices and home safety incidents.

- **Home Safety Devices:** Two indicators were examined with respect to home safety devices, including the presence of working smoke detectors and the presence of working carbon monoxide detectors. Both had statistically significant net increases. While 44 percent of the Treatment Group had a working carbon monoxide detector prior to WAP, 80 percent had one after WAP, a 36 percentage point increase. The Comparison Group had a four percentage point decline, resulting in a net increase of 40 percentage points.
- **Home Safety Incidents:** Seven types of home safety incidents were examined including fire, food poisoning, carbon monoxide poisoning, lead poisoning, and burns. There were no meaningful changes in any of these indicators.

While WAP resulted in increased use of prevention devices, there was no measurable impact on rare safety incidents.

Recommendations

This study provides information on the non-energy benefits from weatherization for a national sample of program participants. More research of this kind is needed to assess these findings and to further estimate the impact of energy efficiency on non-energy impacts. Because such findings may be used in cost-effectiveness tests and impact the level of energy efficiency investments, it is critical to conduct additional studies that provide verification or refutation of these results.

If some of the limitations of this study were addressed, policymakers could have more confidence in the results. Below are some recommendations for addressing the limitations of this study in future research.

- **Sample Attrition:** Program resources could be used to reduce the sample attrition through improved tracking of program participants.
- **Documentation of Weatherization Services:** Data on the specific measures installed in each survey respondent's housing unit would be a valuable input to the analysis.
- **Income and Program Participation:** Information on income and program participation would improve the affordability analysis.
- **Health Questions:** The health status questions could be improved with respect to survey validity and reliability.

Making these improvements would improve the quality of the data and enhance the analytic power of the study.

Additionally, there are certain impacts that are expected to be greater in specific populations, and additional study is needed for subpopulation groups. For example, elderly, disabled,

and individuals with respiratory problems are more likely to be impacted by reductions in mold and mildew and improvements in indoor air quality. Therefore, programs that focus on these households may have greater health impacts. Additionally, our research found that certain impacts were more pronounced in some climate zones, so differential impacts are expected when an individual state or utility territory is studied.

The study did find several areas where the Occupant Survey measured significant non-energy benefits. However, the study did not monetize those benefits. Additional research should be done to monetize the benefits so that they can be incorporated into cost-effectiveness testing.

I. Introduction

The National Weatherization Assistance Program (WAP) Evaluation included surveys with program participants before and after they received the program treatments. One of the key goals of the data collection effort was to estimate the impact of WAP on outcomes beyond energy usage, including health, safety, comfort, and affordability. This report provides a description of the research conducted and an analysis of WAP's impact on these non-energy benefits.

A. *Weatherization Assistance Program*

The U.S. Department of Energy's (DOE) Weatherization Assistance Program was created by Congress in 1976 under Title IV of the Energy Conservation and Production Act. The purpose and scope of the Program as currently stated in the Code of Federal Regulations (CFR) 10CFR 440.1 is "to increase the energy efficiency of dwellings owned or occupied by low-income persons, reduce their total residential energy expenditures, and improve their health and safety, especially low-income persons who are particularly vulnerable such as the elderly, persons with disabilities, families with children, high residential energy users, and households with high energy burden." (Code of Federal Regulations, 2011)

B. *National Evaluation*

At the request of DOE, Oak Ridge National Laboratory (ORNL) developed a comprehensive plan for a national evaluation of WAP. DOE furnished funding to ORNL for this national evaluation. The Scope of Work (SOW) for the evaluation included an Impact Assessment, a Process Assessment, Special Technical Studies, and a Synthesis Report. ORNL subcontracted evaluation research to APPRISE Incorporated and its partners the Energy Center of Wisconsin, Michael Blasnik and Associates, and Dalhoff Associates LLC.

C. *Purpose and Scope of this Follow-up Report*

As part of the WAP evaluation, APPRISE prepared reports on the Baseline Occupant Survey that was conducted in 2011 and the Customer Satisfaction Survey that was conducted in November 2011 and May 2011. The Baseline Occupant Survey examined the status of low-income households that had applied for WAP and were scheduled to have an audit conducted during the summer of 2011, and compared the status of those households to a group of households that had received WAP services about one year prior to the survey. A report on the Baseline Occupant Survey was published in September 2014. The Customer Satisfaction Survey documented which households received WAP services and examined the experience of those households. A report on the Customer Satisfaction Survey was published in September 2014.

The purpose of this report is to analyze the findings from the WAP Follow-Up Survey that was conducted in 2013. The report examines the changes in status for households that received WAP services after the 2011 Baseline Survey and compares their changes in status to changes for the Comparison Group of households. The focus is on assessing the net change in status for households that received WAP services. All of the findings in the report

are based on the analysis of the pre- and post-WAP treatment Occupant Survey data. We analyze the change in the incidence of issues related to health, safety, comfort, and affordability after receiving WAP treatments, as compared to a Comparison Group of earlier WAP participants.

Note that ORNL independently authored a report in September 2014 entitled “Health and Household-Related Benefits Attributable to the Weatherization Assistance Program.” This report provides an additional, independent analysis of the WAP Occupant Survey data.

II. Estimating Non-Energy Benefits

The purpose of this report is to analyze the Occupant Survey data collected in the National WAP Evaluation and provide an estimate of the non-energy impacts of WAP that can be derived from client self-reports. In this section we provide a brief overview of potential non-energy benefits that may result from low-income energy efficiency services, methods that may be used for estimating the magnitude of these benefits, and an overview of the benefits studied in this report.

A. *Non-Energy Benefits Overview*

The non-energy benefits that may arise from WAP cover many issues, some of which are addressed in this study, some were addressed in other WAP studies, and some were not addressed by the WAP evaluation. The benefits can be categorized into the following areas.

- **Affordability:** WAP improves energy efficiency, reduces energy usage, and reduces energy bills for the average participant household. As a result, energy bills should be more affordable, and participants may be more able to meet their energy and other needs.
- **Home Condition and Comfort:** WAP's improvements to the home include air sealing that can mitigate the pathways by which particulate matter in the outdoor air, insects and other pests, and rodents are able to enter the home. WAP treatments can reduce the amount of moisture in the home through repairs, air sealing, and ventilation, and thereby reduce the presence of mold or mildew in the home. However, the air sealing may cause or increase mold if appropriate ventilation is not maintained or added to compensate for the tighter home.

Additionally, the work that WAP performs to improve the shell with air sealing and insulation will reduce drafts in the home and increase the ability of the home to remain warm in the winter and cool in the summer, thereby improving home comfort. The work may also improve the noise barriers provided by the home's shell and reduce perceived noise issues.

- **Health:** If WAP services are successful in improving indoor air quality by eliminating asthma triggers such as mold and other indoor air contaminants, the program may improve the health status of individuals with respiratory problems or may prevent individuals from developing respiratory problems. If WAP services are successful in helping the household to maintain a safe and healthy indoor temperature, WAP may prevent at-risk individuals (i.e., elderly, disabled, and young children) from having heat-related or cold-related health effects and may improve the health status for all household members. However, WAP may negatively impact health if sufficient ventilation is not maintained or created after the home's shell is tightened through air sealing.
- **Safety:** WAP usually installs carbon monoxide detectors and smoke detectors in participants' homes, which increases home safety. WAP may also reduce the risk of

carbon monoxide poisoning or fire by checking, repairing, and replacing combustion equipment in the home. WAP also may reduce the danger of scalding by adjusting the hot water temperature in the home to a safe level.

- **Macroeconomic:** WAP may have net impacts on the state or local economy through job creation and the economic multiplier of those dollars. Additionally, WAP may have positive economic impacts when customers reduce their energy usage and energy spending, and substitute that previous spending with spending on goods and services that have greater economic benefits for the local economy than spending on energy.
- **Environmental:** WAP will have positive environmental benefits because a reduction in energy usage is associated with a reduction in environmental pollutants.

The Occupant Survey responses to questions about the condition of their home and the health status of individuals occupying the home can furnish important information about the possible non-energy benefits associated with WAP. The Occupant Survey does not furnish information on macroeconomic and environmental non-energy benefits; those non-energy benefits were examined in other ways.

B. Non-Energy Benefits Measurement

There are several different methods for measuring the non-energy benefits that are provided through WAP.

- **Home Measurements:** On-site assessments in the home can provide direct estimates of reductions in exposure to mold, moisture, asbestos, carbon monoxide, radon, and other dangerous contaminants. Measurements can also provide information on changes in home temperature and humidity.
- **Health Data:** Data obtained on health conditions and medical utilization can provide estimates of the impact of WAP on the health of the home occupants.
- **Police and Fire Department Data:** Reports from police and fire departments can provide information on the incidence of fires and accidents in the occupants' homes. These data, however, are usually not available at the required level for analysis.
- **Occupant Reports:** Participant reports on home conditions, comfort, health, and safety prior to and following treatment can provide information on the impacts of WAP in all of these areas.

Each of these methods has advantages and limitations. The occupant self-reports discussed in this study represent one important way of measuring non-energy benefits. However, a more complete assessment of non-energy benefits would combine the findings from this study with the findings from research conducted using other methods.

C. Scope of Report

The specific benefits studied in this report are those that were assessed in the pre- and post-Occupant Surveys that were developed by ORNL in collaboration with a WAP advisory committee.

- **Affordability:** This report addresses the impact of WAP on the affordability of energy and other basic needs.
- **Home Condition:** This report examines the impact of WAP on the presence of asthma triggers such as pests, mold, and mildew.
- **Home Comfort:** This report assesses the impact of WAP on the comfort of the home temperature and indoor noise levels.
- **Health:** The health impacts covered in this report include access to medical care, health status, sleep and ability to perform usual activities, asthma conditions and symptoms, general medical symptoms and need for medical care, and work and school missed due to medical problems.
- **Safety:** This report examines the presence of carbon monoxide detectors, smoke alarms, and the incidence of fires and various types of poisoning.

It is important to highlight that the survey did not ask respondents to describe the changes in their home that were observed after WAP services were delivered. Rather, the survey asked the same set of questions in the Baseline Survey and in the Follow-Up Survey. Changes are measured as the difference between the client-reported status at Baseline and the client reported status at Follow-Up, without explicit references to the WAP service delivery.

III. Methodology

This section describes the research design and survey methodology used for the analysis of WAP non-energy benefits.

A. *Research Design*

Pre- and Post-Treatment Occupant Surveys were included in the WAP evaluation to assess the program in ways that went beyond the data available from service delivery records. One important purpose of the Occupant Surveys was to provide estimates of non-energy benefits that resulted from the WAP treatments. Data on affordability, housing conditions, comfort, safety, and health status indicators were collected before and after WAP service delivery for a Treatment and a Comparison Group.

The Baseline Survey was conducted prior to the Treatment Group's home energy audit. While Treatment Group clients may have had some engagement with WAP during program application, these interviews represent the needs and conditions of the participants prior to WAP delivery. The Follow-Up Survey was conducted two years after the Baseline Survey at the same time of year as the Baseline Survey and assesses the same indicators to determine how client status and needs changed. [Note: The Follow-Up Survey was conducted 12 to 24 months after the Treatment Group client received WAP services.] The Comparison Group was surveyed at the same time as the Treatment Group but had already received service delivery at the time of the Baseline Survey. Therefore, the change for Comparison Group provides an assessment of how needs and conditions may have changed due to factors external to WAP. The Comparison Group assessment is a post-post treatment change measurement.

The Treatment Group received WAP services during Program Year 2011 or Program Year 2012, whereas the Comparison Group of households received services during Program Year 2010. The impact of weatherization on non-energy outcomes was estimated using a difference-in-differences approach. By estimating the differences in client status before and after WAP for the Treatment Group, and netting out a similar post to post difference for the Comparison Group, this evaluation design attempts to isolate the impact of WAP. One important pre-condition for this analysis is that the Treatment Group and the Comparison Group are similar enough so that the groups would have followed parallel trends in the absence of the program. Treatment and Comparison Group households were sampled from the same WAP agencies to maximize the probability of this similarity.

B. *Survey Methodology*

The Baseline and Follow-up Occupant Surveys were conducted as part of the National Weatherization Assistance Program Evaluation. These surveys were designed to develop information on home health and safety, energy use behavior, energy affordability, energy knowledge, and occupant health. A Satisfaction Survey was also conducted following service delivery, but the findings from that survey are not part of the non-energy benefits research.

Key aspects of the survey design are described below.

- Agency Sample: A sample of 220 service delivery agencies was selected to represent the 905 WAP service agencies nationwide.
- Treatment Group Sample: Each agency was asked to furnish a list of clients who were income-qualified for the program and scheduled for a WAP audit in Program Year 2011.
- Comparison Group Sample: Each agency was asked to furnish a list of clients who had received WAP services in Program Year 2010.
- Interviews: Sampled Treatment and Comparison Group clients were contacted and interviewed.

Of the 220 sampled agencies, 204 (93 percent) furnished client lists. The survey was successful in completing interviews with clients from 203 of the 204 agencies that furnished client lists.

The telephone interviews were conducted by a contracted telephone center. The interviewers were trained by APPRISE and a sample of interviews were closely monitored to ensure proper data collection. The following contact protocol was used.

- Advance Mailing: APPRISE prepared and mailed advance letters to all sampled clients. These advance letters explained the purpose of the study, alerted the respondent of a \$20 incentive, and gave the client an 800 number that they could use to contact the phone center if they preferred.
- Contact and Screen: The survey center made ten contact attempts to all numbers, ensuring that the time of day and day of the week was properly rotated. The interviewers left messages on answering machines every third call to alert the client of the purpose of the call.
- Spanish Language Interviews: When the telephone center encountered Spanish-speaking households with a language barrier, an APPRISE interviewer re-contacted the households and conducted the interview in Spanish.

C. Attrition Analysis

The Baseline Survey was completed with 1,094 Treatment Group clients and 803 Comparison Group clients, for a total of 1,897 survey respondents. Of the 1,897 Baseline Survey respondents, 139 households' treatment status could not be verified and were deemed ineligible and 15 households had moved. The remaining 1,743 respondents were contacted by phone for the Follow-Up Survey. The Follow-Up Survey was able to determine that 66 treatment households had not completed weatherization and only 454 of the Treatment Group clients received WAP services, continued to live in the weatherized housing unit, and could be contacted for follow-up interviews. Similarly, 430 of the Comparison Group households who continued to live in their weatherized homes could be contacted. That group of 454 Treatment Group households and 430 Comparison Group households serves as the analysis population for this report. All tables include this population unless otherwise reported.

**Table III-1
Attrition**

Population	Treatment Group		Comparison Group	
	#	%	#	%
Baseline Survey Households	1,094	100%	803	100%
Treatment Status Determined	955	87%	803	100%
Complete	454	48%	430	54%
Incomplete	501	40%	373	46%
Final Follow-Up Sample	454		430	

The Follow-Up Survey contact rate was 87 percent, the cooperation rate was 95 percent, and the final response rate was 82 percent. Because only 55 percent of the Baseline Survey respondents could be reached, there is potential for bias in the analysis of non-energy benefits.

**Table III-2
Survey Sample Disposition**

		Baseline		Follow-up	
		#	%	#	%
Sample		4,197	100%	1,743	100%
Interview Completed		1,934	46%	950	55%
Eligible	Break off after Q1	23	>1%	2	>1%
Ineligible	Disconnect/Wrong Number	482	12%	178	10%
	No phone number	20	1%	150	9%
	Terminate (Moved/Deceased)	647	15%	160	9%
Unknown	Refusals	386	9%	81	5%
	No Answer/Answering Machine	625	15%	181	10%
	Call Backs/Cell Phone/Language	80	2%	41	2%
Contact Rate		83%		87%	
Cooperation Rate		88%		95%	
Response rate		73%		82%	

Of the 1934 clients interviewed in the baseline, only 1897 were individually treated units included in the analysis.

While the Baseline Occupant Survey analysis determined that the Treatment and Comparison Groups were largely similar on most of the factors correlated to outcomes, the high rate of attrition warrants a reassessment of the comparability between the Treatment

and Comparison Groups. The following tables show the extent to which, post-attrition, the Treatment and Comparison Groups included in the Follow-Up Survey were similar prior to the Treatment Group's weatherization.

Tables III-3 to III-6 show the proportions of Treatment and Comparison Group by climate, demographics, housing unit characteristics, race, ethnicity, and health factors. There were few significant differences between the Treatment and Comparison Groups across most of the variables that are expected to be correlated to WAP outcomes.

About one quarter of each research group lived in very cold climate zones whereas a tenth live in hot climates. However, the Comparison Group was somewhat less likely to live in the cold climate zone and more likely to live in the moderate climate zone. Where applicable, we also provide sub-group analyses disaggregated by climate zones to understand if this difference might be affecting the results.

Table III-3
WAP Clients by Climate Zone

Climate Zone	Treatment	Comparison
Number of Respondents	454	430
Very Cold	25%	27%
Cold***	49%	41%
Moderate**	16%	21%
Hot	10%	11%
TOTAL	100%	100%

Statistical significance of difference at the ***99 percent, **95 percent, and *90 percent levels.

In terms of demographics and housing unit characteristics, the Comparison Group households were significantly more likely to own their home and to have at least one elderly member over the age of 60.

Table III-4
WAP Clients by Demographics and Housing Unit Characteristics

Demographics	Treatment	Comparison
Number of Respondents	454	430
Single Family Home	78%	81%
Natural Gas Main Heating Fuel	54%	51%
Central Heating System	80%	81%
Home Owner**	89%	94%
At least one Elderly Person*	53%	60%

Demographics	Treatment	Comparison
At least one Child	13%	11%
Employed	31%	31%

Statistical significance of difference at the **95 percent and *90 percent levels.

The racial and ethnic composition of the Treatment and Comparison Groups are statistically equivalent, except for the Hispanic category, and reflect the racial proportions of the national WAP eligible population.

Table III-5
WAP Clients by Race and Ethnicity¹

Race or Ethnicity	Treatment	Comparison
Number of Respondents	454	430
White, Non-Hispanic	73%	77%
Black, Non-Hispanic	17%	15%
Hispanic**	8%	5%
Native American	3%	3%
Hawaiian & Pacific Islander	<1%	<1%
Asian	<1%	<1%
Other	<1%	0%
TOTAL	100%	100%

Statistical significance of difference at the ***99 percent, **95 percent, and *90 percent levels.

Table III-6 assesses survey variables that are correlated with health outcomes. The one health factor where there was a significant and large difference between the Treatment and Comparison Group was the propensity to avoid medical attention. Respondents were defined as having this propensity if they answered “Definitely true” or “Mostly true” to the question, “You will do just about anything to avoid going to the doctor”. The Treatment Group households were more likely to avoid medical attention by about 12 percentage points.

¹ Adds up to slightly more than 100% as respondents were able to select multiple races/ethnicities.

Table III-6
WAP Clients by Health Factors

Determinants of Health	Treatment	Comparison
Number of Respondents	454	430
Dirty Fuel Use for Heating ²	5%	5%
Smokers ³	59%	57%
Health Coverage ⁴	85%	87%
Propensity to seek medical attention ⁵	47%	44%
Propensity to avoid medical attention ^{6***}	51%	39%

Statistical significance of difference at the ***99 percent, **95 percent, and *90 percent levels.

D. Summary of Findings

The APPRISE evaluation team used high quality survey research procedures to maximize response rates and minimize the bias associated with non-response. The Baseline Survey achieved a 73 percent response rate among clients who were eligible for the survey and the Follow-Up Survey achieved an 82 percent response rate. Those combined response rates show that about 60 percent of the eligible households completed both surveys. The 40 percent non-response among eligible households has the potential to bias the study.

However, the definition of an “eligible” household masks other potential sources of bias.

- A household was “eligible” for the study only if a telephone number was available. The study team was not able to obtain a telephone number for about 13 percent of the Baseline Survey sample and about 19 percent of the Follow-Up Survey sample.
- A household was “eligible” for the study only if they remained in the home that was weatherized. About 15 percent of the Baseline Survey sample and about nine percent of the Follow-Up Survey sample had moved from the home that was weatherized.

Each of these issues can introduce bias into the study. In the context of the resources allocated to the surveys, it was not possible to eliminate those potential biases. However, it is important to understand that they can impact the ability to extrapolate from the survey to the population.

² Households that use fuel oil, kerosene, wood or biomass as main heating fuel combined with one of the following main heating equipment: flueless fireplace, portable heater, cooking stove, built-in room heater, heating stove.

³ Respondents who have smoked at least 100 cigarettes in their lifetime, or smoking is permitted anywhere in the household.

⁴ Respondents who have had any kind of health coverage in the past twelve months.

⁵ Respondents who answer “Definitely true” or “Mostly true” to the question, “You go to the doctor as soon as you start to feel bad”

⁶ Respondents who answer “Definitely true” or “Mostly true” to the question, “You will do just about anything to avoid going to the doctor”

IV. Affordability

WAP improves energy efficiency, reduces energy usage, and reduces energy bills for the average participant household. As a result, energy bills should be more affordable, and participants may be more able to meet their energy and other needs. This section examines the impact of WAP on affordability indicators.

This report examines the survey findings for households who live in single family homes (i.e., homes in buildings with one to four housing units) and mobile homes. The WAP evaluation reports from the Recovery Act Period furnish some useful information to put the energy cost savings into context.

- **Single Family Homes:** The average household had first year energy cost savings of \$223, about 12 percent of their energy bill of \$1,863. That is about 1.4 percent of the median household income of \$15,607.
- **Mobile Homes:** The average household had first year energy cost savings of \$190, about ten percent of their energy bill of \$1,926. That is about 1.3 percent of the median household income of \$14,712.
- **Fuel Oil Main Heat:** The highest average first year energy cost savings was realized by households that heated with fuel oil. Their first year energy cost savings were \$392, about 13 percent of their energy bill of \$2,986.

These energy savings are important to low-income households. However, it is important to understand that there are other programs that work to make energy affordable for low-income households. For example, the average LIHEAP program benefit for FY 2011 as reported in the FY 2011 LIHEAP Report to Congress was \$452 per household. The LIHEAP program assists households with their immediate home energy needs, while WAP delivers longer-term benefits to low-income households. These programs work together to help make energy bills affordable for low-income households.

It also is important to note that there are ways that the reduction in energy bills can yield affordability benefits that would not be reported by program participants. Some low-income households participate in ratepayer-funded energy assistance programs in which they receive a rate discount or a fixed credit for the amount of the bill that exceeds a certain percentage of their income. In those situations, since the ratepayers are paying for part of the energy used by the household, the ratepayers would see benefits from any reduction in energy usage by the household.

A. *Affordability and Payment*

Table IV-1 examines the change in the difficulty that participants had paying their energy and other utility bills. The table shows that while 76 percent of participants said it was very hard or hard to pay their energy bills prior to WAP participation, 49 percent said it was very hard or hard following participation, a reduction of 26 percentage points. While the Comparison Group experienced a small decline in such difficulty, the net change was a decline of 20 percentage points. Other indicators examined include not being able to pay energy bills to pay for other utility bills at least every few months, not being able to pay

utility bills to pay for energy bills, or using short-term, high-interest loans to pay for energy bills. While the Treatment Group showed a reduced incidence of these problems, the net change was not statistically significant.

Table IV-1
Difficulty Paying Energy Bills

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Very hard or hard to pay energy bills	76%	49%	-26%***	58%	52%	-6%**	-20%***
Household could not pay energy bills at least every few months to pay for other utility bills	17%	14%	-3%	13%	12%	-1%	-2%
Household could not pay other utility bills at least every few months to pay for energy bills	18%	13%	-6%***	12%	10%	-3%	-3%
Household used short-term, high interest loan to pay for energy bills	15%	12%	-2%	9%	9%	-1%	-2%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table IV-2 examines the change in food affordability. The table shows that while there were statistically significant declines in the percent who could not pay their energy bills to pay for food or worried about having nutritious food, the net change was not statistically significant.

Table IV-2
Difficulty Paying for Food

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Household could not pay energy bills at least every few months to pay for food.	23%	17%	-5%**	13%	11%	-1%	-4%
Household could not buy food at least every few months to pay for energy bills	13%	10%	-4%**	8%	8%	-1%	-3%
Household went without food for 24 hours in the past 4 weeks	5%	5%	0%	6%	5%	-1%	1%
Household has worried about having nutritious food in the past 4 weeks	22%	18%	-4%**	15%	15%	0%	-4%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table IV-3 shows that net changes in the ability to pay for prescription medication were not statistically significant.

Table IV-3
Difficulty Paying for Prescription Medicine

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Household could not pay energy bills at least every few months to fill prescription medicine.	4%	4%	-1%	4%	1%	-3%***	2%
Household could not fill prescription medicine at least every few months to pay for energy bills	15%	9%	-6%***	9%	6%	-3%**	-3%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table IV-4 displays the net impact of WAP on bill affordability by whether there was an elderly household member or a child in the household. The table shows that the net change in whether it was very hard or hard to pay energy bills for households with elderly members was about the same as the WAP population as a whole, but the net impact for households with children was smaller and was not statistically significant.

Table IV-4
Net Change in Difficulty in Paying Energy Bills by Vulnerability Status

Vulnerability Factor	Elderly	Children
Observations	242	60
Very hard or hard to pay energy bills	-20%***	-9%
Household could not pay other utility bills at least every few months to pay for energy bills	-4%	-3%
Household could not buy food at least every few months to pay for energy bills	-3%	1%
Household could not fill prescription medicine at least every few months to pay for energy bills	-3%	8%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table IV-5 displays the net impact of WAP on bill affordability by climate zone. The table shows that the net change in whether it was very hard or hard to pay energy bills was large and statistically significant for households in all climate zones.

Table IV-5
Net Change in Difficulty in Paying Energy Bills by Climate Zone

Climate Zone	Very Cold	Cold	Moderate	Hot
	115	224	71	44
Very hard or hard to pay energy bills	-22%***	-21%***	-19%**	-22%*
Household could not pay other utility bills at least every few months to pay for energy bills	-2%	-4%	-3%	-5%

Climate Zone	Very Cold	Cold	Moderate	Hot
	115	224	71	44
Household could not buy food at least every few months to pay for energy bills	0%	-5%	-6%	0%
Household could not fill prescription medicine at least every few months to pay for energy bills	-3%	-1%	-4%	-9%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

B. Bill Payment

Table IV-6 examines the impact of WAP on disconnection notices, disconnections of utility service, and running out of fuel. The table shows that while there was a statistically significant reduction in receipt of disconnection notices almost every month, the net change was not statistically significant. The net change in the percent that ran out of fuel was a statistically significant three percentage point decline. As previously discussed, the average energy savings for delivered fuel households was somewhat larger than the savings for households that heated their homes with natural gas or electricity.

Table IV-6
Frequency of Disconnect Notices and Disconnections

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Received disconnect notice almost every month	16%	12%	-4% **	13%	11%	-2%	-1%
Electricity or Natural Gas disconnected	3%	2%	-1%	3%	2%	-1%	0%
Fuel ran out	9%	5%	-4% ***	5%	4%	-1%	-3% *

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table IV-7 shows that these changes were not statistically significant for the individual vulnerable groups.

Table IV-7
Net Change in Difficulty in Paying Energy Bills by Vulnerability Status

Vulnerability Factor	Elderly	Children
	242	60
Received disconnect notice almost every month	-2%	6%
Electricity or Natural Gas disconnected	-2%	3%
Fuel ran out	-3%	-7%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table IV-8 shows that these changes were not statistically significant for the individual climate zones except for fuel running out in the moderate zone.

Table IV-8
Net Change in Difficulty in Paying Energy Bills by Climate Zone

Climate Zone	Very Cold	Cold	Moderate	Hot
	115	224	71	44
Received disconnect notice almost every month	-5%	-1%	0%	4%
Electricity or Natural Gas disconnected	1%	0%	1%	0%
Fuel ran out	-1%	-3%	-8%*	0%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table IV-9 examines the impact of WAP on moving, evictions, foreclosure, and other changes in living situations over the last five years. The table shows that there were no meaningful changes in any of these measures.

However, one analytic challenge in using these survey questions is that they reference events “in the last five years.” Because of that, the Follow-Up Survey response would include references to the pre-weatherization period. One might suggest that a one-year reporting period would improve the analysis. However, Table IV-9 shows that these are relatively rare events for the population served by WAP; at most, only 2 percent of households reported having experienced any of those events in the last five years.

Table IV-9
Living Situation Disruption

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Moved due to energy bills	2%	0%	-1%*	1%	1%	0%	-1%
Eviction from home	0%	1%	0%	0%	0%	0%	1%
Foreclosure	2%	2%	0%	2%	2%	0%	0%
Moved in with friends/family	2%	1%	-1%*	1%	1%	0%	-1%
Moved into shelter or been homeless	1%	0%	-1%**	0%	0%	0%	-1%**
Family separation	1%	1%	0%	1%	1%	-1%	0%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

C. Summary of Findings

The WAP impact evaluation reports demonstrate that WAP reduced total energy costs for participating households by an average of over ten percent. This change was associated with a 20 percent decline in the share of households who reported that their energy bill was “hard” or “very hard” to pay. It is possible that the change was due, in part, to changes in LIHEAP program participation or changes in income during the period from 2011 to 2013. However, it is likely that WAP played a major role in that change and that WAP participation will continue to help with energy affordability over the longer term. It also is

important to highlight that program participants in all the different climate zones reported that it was easier to pay their energy bill.

The only other statistically significant net changes that the study identified were the following.

- **Ran Out of Fuel:** A reduction of three percentage points in the incidence of households running out of a delivered fuel.
- **Shelter/Homeless:** A reduction of one percentage point in the report by households of having to move into a shelter in the last five years or having been homeless in the last five years.

The non-energy benefits from improved energy affordability appear to be limited. The participant receives the direct benefit of a lower energy bill. The household can use those funds for other purposes. However, considering the small size of the average energy savings compared to the average household's income, those savings are unlikely to have a significant impact on household finances.

WAP can contribute to longer-term energy sustainability for low-income households. The program is likely to have the greatest impact on households that use high priced fuels (e.g., fuel oil) or that have very high usage. For those households, the non-energy benefits might be substantial. However, a more in-depth study of such households would be needed to clearly document such benefits.

D. *Study Limitations*

While WAP can have important impacts on affordability, these surveys had important limitations in their ability to assess WAP's impact on affordability. The surveys did not collect information on household income, the household's participation in the LIHEAP program, or the household's participation in other types of energy assistance programs. Each of these omitted variables could account for the changes in affordability identified in this section of the report.

Another limitation of this analysis is that the sample sizes make it difficult to document affordability changes by geographic region or by main heating fuel. The WAP Impact Evaluation reports demonstrated that the energy cost savings were much higher for geographic areas with higher energy costs (the Northeast) and for main heating fuels that were more expensive per unit (fuel oil and propane).

V. Housing Conditions and Home Comfort

WAP is designed to make changes to the home that improve the condition of the housing unit and the comfort of the occupants. This section examines the impact of WAP on housing conditions and home comfort including insects and mold, noise, and temperature. It documents the rate at which program participants report changes in the housing unit and considers the types of non-energy benefits that may be associated with those changes.

The study procedures were particularly effective in measuring changes in housing conditions and home comfort because of the way that the questions were asked. The survey questions did not ask the respondent to report on the impact of the WAP service delivery. Rather, in each survey, the respondent was asked to report on the current status of the home or the status of the home over the last year. As such, the propensity for a respondent to provide a socially desirable response was minimized.

A. *Insects and Mold*

Table V-1 displays the change in the incidence of pest infestation. The table shows that the Treatment Group had reductions that were statistically significant and larger than the Comparison Group. For example, while 19 percent of the Treatment Group stated that their home was somewhat infested with cockroaches, spiders, or other insects prior to WAP, 12 percent said it was somewhat infested after WAP, a seven percentage point reduction. The Comparison Group had a three percentage point increase, resulting in a net reduction of ten percentage points.

Table V-1
Level of Insect or Rodent Infestation

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Extremely/very infested with cockroaches, spiders, other insects	5%	2%	-3% **	2%	2%	0%	-3% **
Somewhat infested with cockroaches, spiders, other insects	19%	12%	-7% ***	13%	15%	3%	-10% ***
Extremely/very infested with rats or mice	2%	0%	-2% ***	0%	1%	0%	-2% ***
Somewhat infested with rats or mice	8%	6%	-2%	6%	6%	0%	-2%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table V-2 displays responses about the presence of mold, mildew, odor, or standing water. The table shows that the net change in a mildew odor or musty smell was a decline of ten percentage points. Participants were also less likely to report that they sometimes observe standing water.

Table V-2
Presence of Mold, Mildew Odor or Standing Water

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Mildew odor or musty smell	29%	21%	-8%***	15%	16%	1%	-10%***
Mold	24%	19%	-5%**	17%	17%	-1%	-4%
Always or often observed standing water	5%	4%	-1%	3%	3%	0%	-1%
Sometimes observed standing water	15%	9%	-6%***	7%	7%	-1%	-5%**

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

One interesting finding from Tables V-1 and V-2 is that, for most indicators, the pre-weatherization incidence for the Treatment Group was higher than for the Comparison Group while the post-weatherization incidence for the Treatment Group was usually very similar to the incidence of the Comparison Group. For example, 24 percent of Treatment Group households reported the presence of mold in their home, compared to 17 percent of Comparison Group households. Post-Treatment, only 19 percent of Treatment Group households reported the presence of mold and the Comparison Group percentage remained unchanged at 17 percent. This example demonstrates the way that the post/post Comparison Group works; the Treatment Group incidence is expected to be different from the Comparison Group in the Baseline Survey, but to be similar in the Follow-Up Survey.

Table V-3 examines the net change in infestations, mold, and mildew by climate zone. The table shows the following net impacts that are statistically significant.

- Reduction in the percent that reported the home was extremely or very infested with cockroaches, spiders, or other insects of six percentage points for those in cold climates and of nine percentage points for those in hot climates.
- Reduction in the percent that reported the home was somewhat infested with cockroaches, spiders, or other insects of ten percentage points for those in very cold climates, eight percentage points for those in cold climates, and of 15 percentage points for those in moderate climates.
- Reduction in the percent that reported a mildew odor or musty smell of 18 percentage points for those in cold climates.
- Reduction in the percent that reported mold of nine percentage points for those in cold climates.
- Reduction in the percent that reported they sometimes observed standing water of 12 percentage points for those in very cold climates and of 11 percentage points for those in hot climates.

Table V-3
Net Change in Infestations, Mold, and Mildew by Climate Zone

Climate Zone	Very Cold	Cold	Moderate	Hot
Obs	115	224	71	44
Extremely or very infested with cockroaches, spiders or other insects	3%	-6%***	0%	-9%*
Somewhat infested with cockroaches, spiders or other insects	-10%*	-8%*	-15%**	-4%
Extremely or very infested with rats or mice	-2%	-3%**	-3%	0%
Somewhat infested with rats or mice	-2%	1%	-6%	-9%
Mildew odor or musty smell	-4%	-18%***	1%	-3%
Mold	0%	-9%**	0%	-1%
Always or often observed standing water	1%	-2%	-2%	0%
Sometimes observed standing water	-12%**	-1%	-2%	-11%*

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

B. Comfort

Table V-4 examines the change in noise following WAP participation. The table shows that the Treatment Group had a twelve percentage point reduction in reports of a great deal of noise while the Comparison Group had no reduction.

Table V-4
Level of Outdoor Noise with Windows Shut

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
A great deal of noise	28%	17%	-12%***	12%	12%	0%	-12%***
Some noise	39%	37%	-1%	39%	41%	1%	-3%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table V-5 examines the change in the frequency of draftiness following WAP participation. The table shows that the Treatment Group had a ten percentage point reduction in reports of the home being drafty all of the time, and that the net impact was a decline of nine percentage points.

Table V-5
Frequency of Draftiness

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Drafty all the time	12%	2%	-10%***	4%	3%	-1%	-9%***
Drafty most of the time	17%	4%	-12%***	4%	2%	-2%**	-10%***

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Respondents were asked about the perceived indoor temperature of their home in the winter. While 58 percent of the Treatment Group said their home was comfortable prior to WAP, 82 percent said their home was comfortable in the post survey, a 23 percentage point increase. The Comparison Group only had a four percentage point increase in the percent who said the home was comfortable, and the net change was an increase of 20 percentage points. The change was largely a reduction in the percent who said that their home was cold in the winter.

Table V-6
Perceived Indoor Temperature in the Winter

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Very Cold	6%	2%	-4%***	3%	1%	-2%**	-3%*
Cold	33%	14%	-19%***	15%	14%	-1%	-17%***
Comfortable	58%	82%	23%***	79%	83%	4%*	20%***
Hot	2%	2%	0%	1%	1%	0%	0%
Very hot	0%	1%	0%	0%	0%	0%	0%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

It is important to highlight that this change occurred despite the fact that the clients did not report a change in their thermostat setting. One can show a correlation between a change in draftiness and a change in comfort.

There was also a positive impact of the program on home comfort in the summer. While 57 percent stated that their home was comfortable in the summer prior to services, 71 percent stated that it was comfortable following services, and the net change was an increase of 12 percentage points.

Table V-7
Perceived Indoor Temperature in the Summer

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Very Cold	0%	0%	0%	0%	0%	0%	0%
Cold	3%	2%	0%	2%	3%	1%	-1%
Comfortable	57%	71%	13%***	72%	74%	2%	12%***
Hot	27%	22%	-5%**	22%	18%	-4%*	-1%
Very hot	12%	4%	-8%***	4%	4%	1%	-8%***

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table V-8 displays the reported difficulty of studying faced by a school-aged member of the household due to excessive heat or cold. The table shows that there was no change in the incidence of this issue following WAP services.

Table V-8
Difficulty Studying Faced by School-Aged Member due to Excessive Heat or Cold

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Very frequently or frequently	1%	1%	0%	1%	0%	-1%	0%
Not frequently or Infrequently	3%	2%	-1%	0%	0%	0%	-1%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table V-9 displays the frequency of an unsafe or unhealthy indoor temperature. The table shows that participants were less likely to report that they had an unsafe or unhealthy indoor temperature for some months or one to two months following service delivery, and they were 12 percentage points more likely to report that they never had an unsafe or unhealthy indoor temperature.

Table V-9
Frequency of Unsafe or Unhealthy Indoor Temperature

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Almost every month	3%	1%	-2%**	1%	1%	0%	-2%
Some months	8%	3%	-4%***	3%	4%	1%	-6%***
1-2 months	7%	2%	-5%***	4%	4%	0%	-5%***
Never	81%	93%	12%***	91%	91%	0%	12%***

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

C. Summary of Findings

The statistics presented in this section clearly demonstrate that WAP improved comfort by making the homes more airtight, adding insulation, and improving heating distribution systems. Survey respondents were less likely to report that their homes were drafty, were more likely to report that they could keep their homes at a comfortable temperature, and were less likely to report that their homes had pests and rodents. These are all expected outcomes of the core WAP measures.

The study also found that program participants were less likely to report problems associated with moisture in their homes after receiving weatherization services. It is possible that program participants would report increases in moisture after air sealing in the home, since a “tighter” home is more likely to have increases in the amount of moisture. However, exactly the opposite was reported. The program participants were less likely to observe a mildew or musty smell, the presence of mold, and the presence of standing water.

These important improvements in housing conditions are most likely to have non-energy benefits associated with home maintenance and in client health status.

- Moisture in the home can increase the rate at which housing materials deteriorate. That might reduce longer-term home maintenance costs.
- The incursion of pests, rodents, and other particles from the outside can increase the rate at which household members experience respiratory problems.
- A home that is too cold can cause problems for household members who have circulatory problems. A home that is too hot can cause problems for vulnerable members such as the elderly and young children.

Some of these issues are examined in more detail in later sections of the report. However, the important finding from this section is that there is clear evidence that the condition of the home was improved and the comfort of the household members was increased by the WAP services.

D. Study Limitations

One important limitation of the study is that it is possible that the current performance of WAP is better than the performance of the program at the time of the study for two reasons.

- Over the last five years, WAP has improved quality control procedures by introducing standard work specifications. If those program changes have been effective, it is likely that the program will have even greater impacts on housing conditions and comfort.
- Over the last five years, WAP has adopted the ASHRAE 62.2 requirements that call for increased installation of ventilation in some treated homes, particularly in high moisture areas such as bathrooms and kitchens. If those program changes have been effective, it is likely that the program will have even greater impacts on the amount of moisture in the home and will have impacts on the presences of asthma triggers such as mold or mildew.

These potential changes in the performance of WAP highlight the need for ongoing measurement of program impacts using a range of measurement procedures.

VI. Health Benefits

The findings in Section IV showed that WAP had modest impacts on household energy affordability issues. However, the analysis did not show significant improvements in the ability to pay for food or for prescriptions that might improve health status.

The findings in Section V demonstrated that WAP participation improved the condition of the home and made the home more comfortable. Those changes in the home could impact the health status of household members.

This section examines health insurance and access to medical care, health status, asthma conditions, other medical conditions, and the impact of health status on earnings. It considers whether there are changes in status that can be attributed to either increased energy affordability or improved indoor air quality or indoor temperatures.

A. Health Insurance and Access to Medical Care

Table VI-1 displays health insurance coverage indicators. The table shows that there was no statistically significant net change in health insurance coverage.

Table VI-1
Health Insurance Coverage in the Past 12 Months

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Had any kind of health coverage	85%	83%	-2%	87%	87%	0%	-2%
Had health coverage all year	71%	77%	6% **	76%	79%	3%	3%
Had health & Rx coverage	74%	75%	1%	79%	79%	1%	1%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-2 displays indicators of access to medical care. The table shows that the Treatment Group was less likely to state that they could not afford to see the doctor, afford prescriptions, or had problems paying medical bills. The net change in those who could not afford to see the doctor with coverage was a reduction of seven percentage points, as was the net change in those who could not afford prescriptions with coverage.

Table VI-2
Access to Medical Care in the Past 12 Months

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Could not afford to see doctor with coverage	23%	15%	-8% ***	17%	15%	-2%	-7% **
Could not afford to see doctor without coverage	10%	8%	-2%	7%	6%	-1%	-1%

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Could not afford prescription with Rx coverage	21%	15%	-6%***	17%	17%	0%	-7%**
Could not afford prescription without Rx coverage	4%	2%	-2%**	1%	2%	1%	-3%**
Had problems paying medical bills	40%	33%	-7%***	33%	29%	-4%*	-3%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

It is interesting that the findings in Table VI-2 are most robust for households that have insurance coverage. It is possible that the modest reduction in energy costs for households is enough to help them make co-payments when they have coverage, but it not enough to help them afford to see a doctor or pay for a prescription when they do not have coverage and would have to pay for the full cost of services.

Table VI-3 displays the net change in health insurance coverage and access to medical care by vulnerability status. The table shows that households with elderly members had a net reduction in the inability to see a doctor with coverage of nine percentage points and of an inability to afford prescriptions with coverage of 11 percentage points. Households with children had a net reduction in the inability to afford prescriptions without coverage of six percentage points.

Table VI-3
Net Change in Health Insurance Coverage and Access to Medical Care
By Vulnerability Status

Vulnerability Characteristic	Elderly	Children
Obs	242	60
Had any kind of health coverage	-3%	-3%
Had health coverage all year	1%	14%
Had health & Rx coverage	-6%	6%
Could not afford to see doctor with coverage	-9%**	-4%
Could not afford to see doctor without coverage	1%	1%
Could not afford prescription with Rx coverage	-11%***	0%
Could not afford prescription without Rx coverage	-1%	-6%*
Had problems paying medical bills	-5%	-4%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

B. Health Status

This section examines days of poor physical and mental health and not enough sleep. Table VI-4 shows that there was a net decline of eight percentage points in those who had poor physical health in all 30 most recent days.

Table VI-4
Respondent Days of Poor Physical Health or Mental in the Past 30 days

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Physical							
1-15 days	25%	28%	4%	24%	26%	3%	1%
16-29 days	7%	4%	-3%**	6%	6%	0%	-3%
All 30 days	23%	18%	-5%**	19%	22%	4%	-8%**
Mental							
1-15 days	25%	24%	-1%	24%	21%	-2%	2%
16-29 days	4%	4%	0%	4%	5%	1%	-1%
All 30 days	13%	12%	-2%	14%	11%	-3%*	2%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-5 displays the net change in days of poor health by vulnerability status. The table shows that elderly households had a net decline of 12 percentage points in those who had poor physical health in all 30 most recent days.

Table VI-5
Net Change in Days of Poor Health by Vulnerability Status⁷

Vulnerable Characteristic	Elderly	Children
Obs	242	60
Physical		
1-15 days	3%	-15%
16-29 days	-3%	7%
All 30 days	-12%***	-9%
Mental		
1-15 days	3%	-8%
16-29 days	0%	-1%
All 30 days	3%	-3%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-6 displays reported days of enough sleep and changes in ability to perform usual activities in the past 30 days. There were no significant net impacts on these variables.

⁷ Includes health of respondent or household member.

Table VI-6
Days of Not Enough Sleep and Changes in Ability of Respondent in the past 30 days

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Not enough sleep							
1-15 days	36%	34%	-2%	39%	39%	0%	-2%
16-29 days	10%	9%	<-1%	8%	7%	-1%	0%
All 30 days	20%	21%	1%	16%	16%	<-1%	2%
Change in ability to do usual activities							
1-15 days	28%	25%	-3%	26%	24%	-3%	-1%
16-29 days	10%	7%	-3%*	6%	6%	0%	-3%
All 30 days	9%	9%	0%	12%	13%	1%	-1%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

C. Asthma Conditions and Symptoms

Table VI-7 displays the respondent's reported asthma status. The table shows no significant net changes in the asthma condition of the respondent.

Table VI-7
Respondent Asthma Status

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Respondent has ever had asthma	19%	21%	2%***	19%	21%	2%***	0%
Respondent still has asthma	15%	17%	2%**	14%	15%	1%	1%
Respondent has never had asthma	76%	74%	-2%***	76%	74%	-2%**	-1%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-8 displays the number of times that the respondent visited a doctor or health professional for a routine checkup for asthma in the past 12 months. The table shows that there were no changes in these indicators.

Table VI-8
Doctor Visits for Routine Asthma Checkups in Past 12 Months

Number of Doctor Visits	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Once in 12 months	4%	4%	-1%	3%	4%	1%	-2%
2-5 times in 12 months	7%	8%	1%	6%	6%	0%	1%

Number of Doctor Visits	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
6 or more times in 12 months	2%	2%	0%	1%	2%	0%	0%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-9 displays how long the respondent stated it had been since he/she last had any asthma symptoms. The table shows no significant changes in these indicators.

Table VI-9
Length of Time since Asthma Symptoms

Time Since Last Asthma Symptoms	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
1-6 days ago	6%	6%	0%	5%	6%	1%	0%
1-12 weeks ago	4%	4%	0%	4%	5%	0%	0%
12 weeks –1 year ago	3%	4%	1%	2%	3%	1%	-1%
More than a year ago	4%	4%	0%	4%	4%	0%	0%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-10 displays whether the respondent had an overnight hospital stay or an emergency visit to a hospital for asthma in the past 12 months. The table shows no significant changes in these indicators.

Table VI-10
Hospital Visits for Asthma in Past 12 Months

Hospital Visit	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Overnight stay	3%	2%	-1%	1%	1%	0%	0%
Emergency visit	2%	2%	0%	3%	2%	0%	1%

Table VI-11 displays the net change in respondent asthma status by vulnerability status, location, climate zone, and smoker status. While a few of the net changes are statistically significant, the change is a small number of percentage points and represents only a few households. Additionally, given the number of sub-group indicators examined, it is expected that one would find a certain number of statistically significant changes, so these are not considered as measured non-energy benefits of WAP.

Table VI-11
Net Change in Respondent Asthma Status
By Vulnerability Status, Location, Climate Zone, and Smoker Status

	Vulnerable Status		Location			Climate Zone				Smoker	
	Elderly	Child	Urban	Town/ Suburb	Rural	Very Cold	Cold	Moderate	Hot	Smoker	Non- Smoker
Obs	242	60	145	162	142	115	224	71	44	270	184
Ever had asthma	0%	2%	1%	0%	1%	-2%	1%	4%*	-4%	1%	0%
Still has asthma	0%	3%	1%	1%	1%	-1%	0%	7%*	-2%	1%	1%
Never had asthma	0%	-2%	-1%	0%	-1%	1%	-1%	-4%*	4%	-1%	-1%
Visited doctor											
Once in 12 months	-3%	-2%	-1%	-2%	-2%	0%	-4%*	4%	-6%*	-2%	-2%
2-5 times in 12 months	2%	-2%	-1%	2%	1%	-2%	4%	-1%	-2%	4%**	-4%
6+ times in 12 months	0%	2%	1%	0%	-1%	2%	-1%	0%	0%	-1%	2%
Latest symptoms											
1-6 days ago	0%	1%	1%	0%	-2%	-1%	-2%	5%	0%	1%	-2%
1-12 weeks ago	-1%	1%	0%	-1%	0%	-1%	-2%	3%	2%	-1%	1%
12 weeks -1 year ago	0%	-1%	2%	0%	-2%	2%	-1%	-1%	-4%	-2%	1%
More than a year ago	0%	1%	-3%	0%	3%	-2%	2%	0%	-2%	0%	0%
Hospital Visit											
Overnight stay only	-2%	2%	-3%	3%**	-1%	-3%*	0%	2%	0%	0%	-1%
Emergency visit only	-1%	-2%	-1%	1%	2%	0%	-1%	5%*	0%	-1%	2%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-12 displays the net change in respondent asthma status by health insurance coverage. The only statistically significant change was for those households with no health insurance coverage in the Pre- or Post-Treatment period, and the sample size was only 36 households. These respondents were less likely to have their latest symptoms one to twelve weeks ago and were more likely to have had their last symptoms 12 weeks to one year ago.

Table VI-12
Net Change in Respondent Asthma Status by Health Insurance Coverage

	Status Changed		No Status Change	
	Changed to not having coverage	Changed to having coverage	Has coverage	No coverage
Obs	39	33	345	36
Ever had asthma	0%	0%	0%	6%
Still has asthma	-3%	0%	1%	6%
Never had asthma	0%	0%	0%	-6%

	Status Changed		No Status Change	
	Changed to not having coverage	Changed to having coverage	Has coverage	No coverage
Obs	39	33	345	36
Visited doctor				
Once in 12 months	3%	3%	-2%	-6%
2-5 times in 12 months	-2%	3%	1%	6%
6+ times in 12 months	-3%	0%	0%	0%
Latest symptoms				
1-6 days ago	0%	-3%	0%	-4%
1-12 weeks ago	0%	0%	1%	-10%*
12 weeks -1 year ago	0%	0%	-2%	16%**
More than a year ago	0%	3%	0%	4%
Hospital Visit				
Overnight stay only	0%	0%	0%	-3%
Emergency visit only	0%	-3%	2%	-7%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

D. Medical Issues

Table VI-13 examines whether a member of the household needed medical attention because of the home temperature. The table shows that there are no significant net impacts on needing medical attention because of home temperature.

Table VI-13
Needed Medical Attention because of Home Temperature

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Needed medical attention because the home was too cold in the past year	3%	1%	-2%*	2%	1%	-1%	-1%
Needed medical attention because the home was too hot in the past year	2%	2%	-1%	1%	1%	0%	0%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-14 examines the presence of shortness of breath and headaches and shows that there are no statistically significant changes in these indicators.

Table VI-14
Health Symptoms

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Shortness of breath when lying down, waking up, or with light work or light exercise in the past 3 months	34%	32%	-2%	35%	34%	-1%	-1%
Headaches that are either new or more frequent or severe than ones you have had before in the past 3 months	17%	15%	-3%	13%	14%	0%	-3%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-15 displays medical issues verified by the doctor in the past 12 months. The table shows no statistically significant net changes in these variables.

Table VI-15
Prevalence of Medical Issues Verified by Doctor in the Past 12 Months

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Three or more ear infections per year	7%	7%	0%	6%	6%	0%	0%
Allergies	28%	31%	3%	21%	28%	7%***	-4%
The flu	21%	18%	-3%	16%	16%	-1%	-2%
Persistent cold symptoms more than 14 days	20%	14%	-6%***	17%	14%	-4%	-3%
Sinusitis	37%	33%	-4%*	34%	34%	0%	-4%
Bronchitis	24%	22%	-2%	22%	19%	-3%	1%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-16 displays the net change in health and medical issues by vulnerability status, location, climate zone, and smoker status. Most of these changes are not statistically significant with the following exceptions.

- Headaches: There was an eight percentage point reduction in headaches that are either new or more frequent or severe in the past three months for respondents in urban areas and in towns or suburbs.
- Allergies: There was an 11 percentage point reduction for urban households, ten percentage point reduction for households in very cold climates, and 12 percentage point reduction for nonsmokers in allergies.
- Flu: There was an eight percentage point reduction in the flu for households in cold climates.
- Cold Symptoms: There was a nine percentage point reduction in persistent cold symptoms for households in rural areas.
- Sinusitis: There was a 14 percentage point reduction in sinusitis for households in urban areas.

Table VI-16
Net Change in Level of Health and Medical Issues
By Vulnerability Status, Location, Climate Zone, and Smoker Status

	Vulnerable Status		Location			Climate Zone				Smoker	
	Elderly	Child	Urban	Town/ Suburb	Rural	Very Cold	Cold	Moderate	Hot	Smoker	Non- Smoker
Obs	242	60	145	162	142	115	224	71	44	270	184
Needed medical attention because the home was too cold in the past year	-2%	-3%	-2%	-2%	1%	-1%	0%	-2%	-4%	1%	-3%*
Needed medical attention because the home was too hot in the past year	-1%	2%	-1%	-1%	0%	3%	-2%	1%	-4%	-1%	1%
Shortness of breath when lying down, waking up, or with light work or light exercise in the past 3 months	-3%	8%	5%	-1%	-7%	9%	-5%	-6%	5%	-3%	1%
Headaches that are either new or more frequent or severe than ones you have had before in the past 3 months	-1%	9%	-8%*	-8%*	6%	2%	-2%	-10%	-7%	-2%	-4%
Three or more ear infections per year	-2%	-3%	1%	4%	-5%**	4%	-2%	2%	-4%	3%	-4%
Allergies	-6%	-8%	-11%**	1%	-2%	-10%*	3%	-8%	-6%	3%	-12%**
The flu	-1%	-5%	-4%	-7%	4%	4%	-8%*	2%	2%	0%	-5%
Persistent cold symptoms lasting more than 14 days	-2%	0%	-2%	2%	-9%*	-2%	-1%	-5%	-11%	-3%	-3%
Sinusitis	-5%	-2%	-14%**	-4%	4%	2%	-6%	1%	-13%	-3%	-4%
Bronchitis	-1%	-5%	-3%	9%*	-2%	4%	4%	-5%	-1%	5%	-3%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-17 displays the change in health and medical issues by health insurance coverage. The table shows that households who did not have health insurance before WAP and then had health insurance in the post period were 31 percentage points more likely to be diagnosed with the flu (only 33 households in the group) and those with health insurance in both periods were seven percentage points less likely to be diagnosed with the flu or with sinusitis.

Table VI-17
Net Change in Respondent Health and Medical Issues by Health Insurance Coverage

	Changed to not having health coverage	Changed to having health coverage	No status change- Has coverage	No status change- No coverage
Obs	39	33	345	36
Needed medical attention because the home was too cold in the past year	3%	-3%	-2%	4%
Needed medical attention because the home was too hot in the past year	0%	-3%	-1%	3%
Shortness of breath when lying down, waking up, or with light work or light exercise in the past 3 months	15%	0%	-4%	4%
Headaches that are either new or more frequent or severe than ones you have had before in the past 3 months	-1%	-9%	-4%	17%
Three or more ear infections per year	-7%	0%	0%	10%
Allergies	8%	-12%	-4%	-2%
The flu	6%	31%***	-7%**	2%
Persistent cold symptoms lasting more than 14 days	-3%	-3%	-3%	-7%
Sinusitis	5%	0%	-7%*	22%
Bronchitis	4%	-12%	2%	8%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

E. Earnings Impact

Table VI-18 examines the number of work days missed due to illness or injury. The table shows that there was a net decrease in the percent with no days of work missed of six percentage points and a net increase in those with one to five days missed of six percentage points, showing a worsening of this indicator.

Table VI-18
Work Days Missed by Primary Wage Earner Due to Illness or Injury

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
No days	21%	17%	-4%*	16%	18%	2%	-6%**
1-5 days	6%	11%	5%***	9%	8%	-1%	6%**
6-10 days	2%	2%	0%	3%	2%	0%	0%
11-30 days	2%	2%	1%	2%	1%	-1%	1%
More than 30 days	1%	1%	0%	1%	2%	1%	-1%
Not employed	69%	67%	-2%	69%	68%	-1%	-1%
Average	1.59	1.87	0.27	1.73	2.28	0.55	-0.28

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-19 examines the number of work days missed due to illness or injury of a household member. The table shows that there were no significant changes in this indicator.

Table VI-19
Work Days Missed by Primary Wage Earner
Due to Illness or Injury of Household Member

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
No days	19%	20%	2%	17%	18%	1%	0%
1-5 days	4%	6%	1%	5%	4%	-1%	2%
6-10 days	1%	1%	0%	1%	1%	0%	-1%
11-30 days	1%	0%	0%	1%	1%	0%	0%
More than 30 days	0%	0%	0%	0%	0%	0%	0%
Not employed or no member illness	75%	73%	-2%	77%	76%	-1%	-1%
Average	0.34	0.28	-0.06	0.37	0.53	0.16	-0.21

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-20 examines the number of school days missed due to illness or injury. The table shows that there were no meaningful changes in this indicator.

Table VI-20
School Days Missed by School-Aged Children due to Illness or Injury

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
No days	6%	6%	0%	4%	6%	1%	-1%
1-5 days	9%	10%	2%	10%	7%	-2%	4% *
6-10 days	4%	2%	-2% **	4%	4%	0%	-2%
11-30 days	4%	2%	-2% ***	2%	1%	-1%	-2% *
More than 30 days	0%	0%	0%	1%	0%	-1%	0%
Not in school	76%	79%	2%	80%	82%	2%	0%
Average	1.64	0.78	-0.86***	1.30	0.75	-0.55*	-0.31

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

Table VI-21 displays the net change in work or school days missed by health insurance coverage. The table shows an increase in the number of work days missed for those with no health insurance coverage in both periods (only 36 households).

Table VI-21
Net Change in Average Earnings Impact by Health Coverage Status

	Changed to not having health coverage	Changed to having health coverage	No status change- Has coverage	No status change- No coverage
Obs	39	33	345	36
Work days missed by primary wage earner due to their illness or injury	-5.16	-1.36	-0.50	7.54**
Work days missed by primary wage earner due to household member's illness or injury	0.17	-0.09	-0.35	0.87
School days missed by household member due to illness or injury	-1.66	-0.37	-0.28	0.70

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

F. Summary of Findings

This section examined an extensive number of indicators that could be affected by participation in WAP. It looked at: Access to Medical Care, Health Status, Asthma, Other Medical issues, and Earnings. The analysis in Section V found that WAP had a significant impact on the condition of the housing unit and on the comfort of household members. However, the analysis in this section found that while those improvements appear to be associated with some health benefits, there were relatively few benefits for which there were statistically significant changes.

The first topic reviewed in this section of the report was Access to Medical Care. The study did not find that there was any statistically significant change in the percentage of households with health insurance coverage. It did find that, particularly for households who have coverage, the households were less likely to report that they could not afford to see a doctor or to pay for prescriptions. Both of those changes could be related to the modest reduction in energy costs and could be associated with improved health for program participants.

The second topic reviewed was Health Status. The study found that there was a statistically significant reduction in the share of program participants who reported that they had poor health status every day of the last 30 days. It is possible that improvements in the indoor air quality could reduce the number of days that a person feels that they are in poor health.

The third topic reviewed was Asthma. WAP is likely to, on average, reduce the share of households that have asthma triggers. However, the analysis did not find any statistically significant reduction in the statistics related to asthma. It is important to remember that the survey questions related to asthma were found to have some important issues from the perspective of reliability (i.e., households were not always able to furnish consistent answers between the two surveys).

The fourth topic reviewed was Other Medical Issues. The analysis did not find that there were statistically significant changes in the rate at which other medical issues occurred in the population.

The fifth topic reviewed was Earnings. The analysis did not find that there were statistically significant changes in earning from improved health status.

Overall, there were a few modest health benefits associated with WAP participation. The findings from Section V clearly show that the program improved the condition of the home and the comfort for household members. However, that does not appear to have translated into major health impacts.

G. Study Limitations

There are many challenges when attempting to collect information on the health status of household.

- **Respondent Knowledge:** The survey respondent was asked to report on his or her own health status and on the health status of others in the home. While the individual will be likely to have complete information on his or her own health status, he or she will not always have complete information on the status of others in the household.
- **Consistent Respondent:** Because of the respondent knowledge issue, the Follow-Up Survey was designed to be conducted with the same respondent as the Baseline Survey. However, in-depth analysis of survey records found that it was not always possible to interview the same respondent for both surveys.

One important study limitation identified at the time of the survey was the response to the questions related to asthma. The Follow-Up Survey data checking routines found that a significant number of clients who reported that they had asthma in the Baseline Survey then reported in the Follow-Up Survey that they had never had asthma. The survey team conducted callbacks to all survey respondents who changed their asthma status between the Baseline and the Follow-Up Survey. Those callbacks found a significant amount of error in asthma reported due to a number of factors. A revised data set was prepared with improved information on asthma. However, any statistics related to asthma are potentially biased because of difficulties in obtaining consistent survey responses related to those questions.

VII. Safety Benefits

WAP conducts a comprehensive inspection of the home prior to installing any weatherization measures. That inspection serves two purposes. First, it helps to identify any active issues in the home related to CO from combustion appliances, poor wiring, or high water heater temperatures. Second, it helps to alert the weatherization crew to ensure that the weatherization procedures do not increase the risk of combustion gases entering the home and do not spread lead paint dust around the home while installing weatherization measures.

This section assesses the safety benefit impacts of WAP including CO and smoke detectors, CO poisoning, fires, and burns. It first examines the rate at which clients report that home safety devices were installed in the home. It then examines the extent to which participant households experienced comparatively rare events related to CO poisoning, food poisoning, or fires.

A. Home Safety Devices

Table VII-1 displays the percent of households that had a working smoke detector and carbon monoxide monitor. The table shows a large net impact in the presence of these devices, especially for carbon monoxide detectors with a 40 percentage point net increase.

Table VII-1
Presence of Home Safety Devices

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Has working smoker detectors	90%	97%	7%***	97%	96%	-1%	8%***
Has working carbon monoxide monitors	44%	80%	36%***	76%	73%	-4%*	40%***

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

B. Safety Impacts

Table VII-2 displays the percentage of respondents that experienced home safety incidents. One important finding from this table is that these risks in homes are relatively rare; they occur in no more than one percent of homes. The table shows no meaningful changes in any of these indicators.

Table VII-2
Home Safety Incidents

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Fire department called to put out fire	1%	0%	-1%**	1%	0%	-1%**	0%
Fire from a an alternative heating source	1%	1%	0%	1%	1%	0%	0%
Needed medical attention due to fire	0%	0%	0%	0%	0%	0%	0%

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Food poisoned from eating food inside your home and therefore went to see a medical professional in the past 12 months	1%	0%	-1%*	0%	0%	0%	-1%*
Poisoned by breathing in carbon monoxide, and therefore went to see a medical professional in the past 12 months	0%	0%	0%	0%	1%	0%	0%
Lead poisoned and therefore went to see a medical professional in the past 12 months	0%	0%	0%	0%	0%	0%	0%
Burned from scalding hot water coming out of a faucet or showerhead in your home in the past 12 months	1%	0%	0%	1%	1%	1%	-1%

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

C. Summary of Findings

This section examined whether there was any indication from the Occupant Survey that WAP had a significant impact on the incidence of safety events in the households treated by the program. Both prior to weatherization and after weatherization, these are extremely rare events.

VIII. Summary and Recommendations

This section provides a summary of findings and recommendations for continued research and development of information on non-energy benefits.

A. *Impacts*

This study provided an analysis of the impacts of WAP on energy affordability, home conditions, and health conditions based on Pre- and Post-Treatment participant and Comparison Group surveys. Many potential impacts were examined. Below we provide a summary of the findings and Table VIII-1 displays findings for all statistically significant net impacts among the full population. The earnings impacts are shaded in grey because the program had a negative effect on these variables.

The affordability can be put into context. The average savings was about 12 percent of the total energy bill. While that can make the bill easier to pay, the average savings was about \$250 compared to \$15,000 in income. That is unlikely to have a major impact on the overall affordability for the household. The delivered fuel savings were closer to \$500 and would be expected to have a somewhat greater impact.

- **Affordability:** Ten indicators were examined relating to affordability, including difficulty paying energy bills, tradeoffs in paying energy and utility bills, use of short-term loans, ability to afford food, need to go without food, worries about nutritious food, and ability to afford medicine.

Only one of these indicators had a statistically significant net change. While 76 percent of participants said it was very hard or hard to pay their energy bills prior to WAP participation, 49 percent said it was very hard or hard following participation, a reduction of 26 percentage points. While the Comparison Group experienced a small decline in such difficulty, the net change was a decline of 20 percentage points.

While elderly households experienced the same net decline of 20 percentage points in saying it was very hard or hard to pay the energy bills, families with children did not have a statistically significant net difference.

- **Bill Payment:** Three indicators were examined with respect to bill payment including receipt of disconnection notices, termination of electric or natural gas service, or ran out of fuel. The one statistically significant net change was a decline of three percentage points in those who ran out of fuel. There was an eight percentage point net decline in this indicator for those in the moderate climate zones.
- **Living Status Disruption:** Six indicators were examined with respect to living situation disruptions including the need to move due to energy bills, evictions, foreclosures, moving in with others or into a shelter, and family separation. There was no meaningful impact on any of these measures.

The next set of indications address what WAP does best. It air seals and insulates homes. It works to reduce the amount moisture in the home. It is clear that this should have a significant impact on the status of the home.

- **Pests:** Four indicators were examined in this area and three of the four indicators had statistically significant net changes. While 19 percent of the Treatment Group stated that their home was somewhat infested with cockroaches, spiders, or other insects prior to WAP, 12 percent said it was somewhat infested after WAP, a seven percentage point reduction. The Comparison Group had a three percentage point increase, resulting in a net reduction of ten percentage points. Other changes were smaller.

Changes in the incidence of pests were largest in the moderate climate zone but were seen in all climate zones.

- **Mold and Moisture:** Four indicators were examined with respect to mold and water, and two of the four indicators had statistically significant net changes. While 29 percent of the Treatment Group stated that their home had a mildew odor or musty smell prior to WAP, 21 percent said there was such an odor after WAP, an eight percentage point reduction. The Comparison Group had a one percentage point increase, resulting in a net reduction of ten percentage points. Participants were also less likely to report that they sometimes observed standing water.

Reductions in the presence of a mildew odor or musty smell, and in mold, were only found in the cold climate zone. Reductions in observed standing water were found in the very cold and hot climate zones.

- **Noise:** Two indicators were examined with respect to noise and there was a large impact on those who reported a great deal of noise. While 28 percent of the Treatment Group stated that there was a great deal of noise prior to WAP, 17 percent said there was a great deal of noise after WAP, a 12 percentage point reduction. The Comparison Group had no change, resulting in a net reduction of 12 percentage points.
- **Draftiness:** Two indicators were examined with respect to draftiness and both had a statistically significant net change. While 17 percent of the Treatment Group stated that the home was drafty most of the time prior to WAP, four percent said the home was drafty most of the time after WAP, a 12 percentage point reduction. The Comparison Group had a two percentage point reduction, resulting in a net reduction of ten percentage points.
- **Perceived Indoor Temperature:** Ten indicators with respect to indoor temperature were examined and five changes had statistically significant net impacts.

While 58 percent of the Treatment Group stated that the home's winter temperature was comfortable prior to WAP, 82 percent said the home's winter temperature was comfortable after WAP, a 23 percentage point increase. The Comparison Group had a

four percentage point increase, resulting in a net increase of 20 percentage points. They were also less likely to state that the home was too cold.

There was also a positive impact in the summer. While 57 percent of the Treatment Group stated that the home's summer temperature was comfortable prior to WAP, 71 percent said the home's summer temperature was comfortable after WAP, a 13 percentage point increase. The Comparison Group had a two percentage point increase, resulting in a net increase of 12 percentage points. They were also less likely to state that the home was very hot in the summer.

- **Indoor Temperature Impacts:** Six indicators were examined with respect to the impacts of the home's indoor temperature including difficulty studying and whether the temperature was unsafe. Neither of the studying impacts were meaningful or statistically significant, but three of the four unsafe temperature impacts were.

While 81 percent of the Treatment Group stated that the home never had an unsafe or unhealthy indoor temperature prior to WAP, 93 percent said the home never had an unsafe or unhealthy temperature after WAP, a 12 percentage point increase. The Comparison Group had no change, resulting in a net increase of 12 percentage points.

- **Health Insurance:** Three indicators were examined and there were no statistically significant net changes in having health insurance.
- **Access to Medical Care:** Five indicators were examined including ability to afford to see a doctor, ability to afford prescriptions, and problems paying medical bills. There were statistically significant net impacts on three of those indicators.

While 23 percent of the Treatment Group stated that they could not afford to see a doctor with health insurance coverage prior to WAP, 15 percent said they could not afford to see a doctor with coverage after WAP, an eight percentage point decline. The Comparison Group had a two percentage point decline, resulting in a net decline of seven percentage points. They were also less likely to state that they could not afford prescriptions.

While households with elderly members were less likely to report that they could not afford to see the doctor with coverage and could not afford their prescription with coverage following the WAP treatment, households with children were less likely to report that they could not afford the prescription without coverage following WAP treatment.

- **Health Status:** Three indicators of physical and three indicators of mental health were examined. There was one statistically significant net impact on physical health.

While 23 percent of the Treatment Group stated that they had poor physical health all of the past 30 days prior to WAP, 18 percent said they had poor physical health all of the past 30 days after WAP, a five percentage point decline. The Comparison Group had a four percentage point increase, resulting in a net decline of eight percentage points.

The elderly had a net decline of twelve percentage points in having had poor physical health all of the past 30 days, but households with children did not have a statistically significant impact.

- **Sleep and Activity:** Three indicators of enough sleep and three indicators of ability to do usual activities were examined. There were no significant net impacts on these variables.
- **Asthma Conditions and Symptoms:** Twelve indicators were examined including whether the respondent had asthma, doctor visits for asthma, time since last asthma symptoms, and hospital visits for asthma. There were no significant net impacts on these variables.
- **Medical Issues:** Ten indicators were examined including need for medical attention due to home temperature, health symptoms, and medical issues verified by a doctor. There were no significant net impacts on these variables for the population as a whole.

There were some statistically significant net changes in certain population subgroups. However, given the number of sub-group indicators examined, it is expected that one would find a certain number of statistically significant changes, so these are not considered as measured non-energy benefits of WAP. This is an important area for future study.

- **Earnings Impact:** Twenty-one indicators were examined in this area including work days missed by primary wage earner due to illness or injury and school days missed due to illness or injury.

There was a net decrease in the percent with no days of work missed of six percentage points and a net increase in those with one to five days missed of six percentage points, showing a worsening of this indicator.

- **Home Safety Devices:** Two indicators were examined in this area, including presence of working smoke detectors and presence of working carbon monoxide detectors. Both had statistically significant net increases.

While 44 percent of the Treatment Group had a working carbon monoxide detector prior to WAP, 80 percent had one after WAP, a 36 percentage point increase. The Comparison Group had a four percentage point decline, resulting in a net increase of 40 percentage points.

- **Home Safety Incidents:** Seven home safety incidents were examined including fire, food poisoning, carbon monoxide poisoning, lead poisoning, and burns. There were no meaningful changes in any of these indicators.

**Table VIII-1
Impact Summary**

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
AFFORDABILITY							
Very hard or hard to pay energy bills	76%	49%	-26% ***	58%	52%	-6% **	-20% ***
BILL PAYMENT							
Fuel ran out	9%	5%	-4% ***	5%	4%	-1%	-3% *
PESTS							
Extremely/very infested w/cockroaches, spiders, other	5%	2%	-3% **	2%	2%	0%	-3% **
Somewhat infested w/cockroaches, spiders, other	19%	12%	-7% ***	13%	15%	3%	-10% ***
Extremely/very infested with rats or mice	2%	0%	-2% ***	0%	1%	0%	-2% ***
MOISTURE							
Mildew odor or musty smell	29%	21%	-8% ***	15%	16%	1%	-10% ***
Sometimes observed standing water	15%	9%	-6% ***	7%	7%	-1%	-5% **
NOISE							
A great deal of noise	28%	17%	-12% ***	12%	12%	0%	-12% ***
DRAFTINESS							
Drafty all the time	12%	2%	-10% ***	4%	3%	-1%	-9% ***
Drafty most of the time	17%	4%	-12% ***	4%	2%	-2% **	-10% ***
INDOOR WINTER TEMPERATURE							
Very Cold	6%	2%	-4% ***	3%	1%	-2% **	-3% *
Cold	33%	14%	-19% ***	15%	14%	-1%	-17% ***
Comfortable	58%	82%	23% ***	79%	83%	4% *	20% ***
INDOOR SUMMER TEMPERATURE							
Comfortable	57%	71%	13% ***	72%	74%	2%	12% ***
Very hot	12%	4%	-8% ***	4%	4%	1%	-8% ***
UNSAFE/UNHEALTHY INDOOR TEMP							
Some months	8%	3%	-4% ***	3%	4%	1%	-6% ***
1-2 months	7%	2%	-5% ***	4%	4%	0%	-5% ***
Never	81%	93%	12% ***	91%	91%	0%	12% ***
MEDICAL CARE ACCESS PAST 12 MONTHS							
Could not afford to see doctor with coverage	23%	15%	-8% ***	17%	15%	-2%	-7% **
Could not afford prescription with Rx coverage	21%	15%	-6% ***	17%	17%	0%	-7% **
Could not afford prescription without Rx coverage	4%	2%	-2% **	1%	2%	1%	-3% **

	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
DAYS OF POOR PHYSICAL HEALTH							
All 30 days	23%	18%	-5% **	19%	22%	4%	-8% **
EARNINGS IMPACT							
No days	21%	17%	-4% *	16%	18%	2%	-6% **
1-5 days	6%	11%	5% ***	9%	8%	-1%	6% **
HOME SAFETY DEVICES							
Has working smoke detectors	90%	97%	7% ***	97%	96%	-1%	8% ***
Has working carbon monoxide monitors	44%	80%	36% ***	76%	73%	-4% *	40% ***

Statistical significance at the ***99 percent, **95 percent, and *90 percent levels.

B. Recommendations

This study provides information on the non-energy benefits from weatherization for a national sample of program participants. More research of this kind is needed to assess these findings and to further estimate the impact of energy efficiency on non-energy impacts. Because such findings may be used in cost-effectiveness tests and impact the level of energy efficiency investments, it is critical to conduct further studies that provide verification or refutation of these results.

If such research is conducted, it is important that it address some of the limitations of this study.

- **Sample Attrition:** Because this was a national sample of program participants, it was difficult to assess whether and when a client received weatherization services, and to use program resources to track the location of clients. If this study were done at the state level, it would be possible to use program records, rather than client response to track receipt of services and client location.
- **Weatherization Services:** This study did not examine the specific measures that were installed in each home. The study would have been more robust in terms of attributing benefits to specific services if it had been able to collect those measure-level data and to compare outcomes for households that received a particular service (e.g., ventilation measures) to those who did not.
- **Additional Questions:** This survey did not include information on income or LIHEAP program participation. If that information was collected from the survey respondent and/or from program records, the study would be better able to examine affordability issues.
- **Improved Questions:** The questions related to health status are particularly challenging. It is important to keep testing those questions to determine how to get the most valid and reliable data.

All of these improvements would make the study more robust and would give program planners better information on how to attribute non-energy benefits to other programs.

Additionally, there are certain impacts that are expected to be greater in specific populations, and more research is needed for subpopulation groups. For example, elderly, disabled, and individuals with asthma are more likely to be impacted by reductions in mold and mildew and improvements in indoor air quality. Therefore, programs that focus on these households may have greater health impacts. Our research found that certain impacts were more pronounced in some climate zones, so differential impacts are expected when an individual state or utility territory is studied.

The study did find several areas where the Occupant Survey measured significant non-energy benefits. However, the study did not monetize those benefits. Further research should be done to monetize the benefits so that they can be incorporated into cost-effectiveness testing.